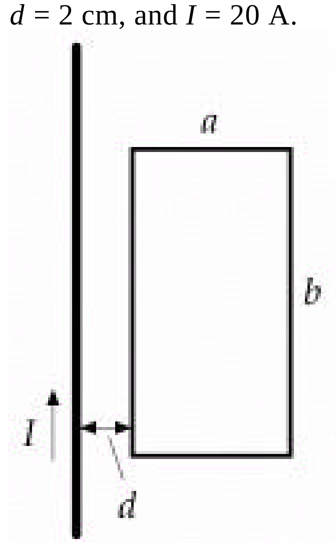
SP 222 Homework Chapter 30 Due APR 2000 Name ___________________________

2 · A circular coil has 25 turns and a radius of 5 cm. It is at the equator, where the earth's magnetic field is 0.7 G north. Find the magnetic flux through the coil when its plane is (*a*) horizontal, (*b*) vertical with its axis pointing north, (*c*) vertical with its axis pointing east, and (*d*) vertical with its axis making an angle of 30° with north.

9* ·· A solenoid has n turns per unit length, radius R_1, and carries a current I. (*a*) A large circular loop of radius $R_2 > R_1$ and N turns encircles the solenoid at a point far away from its ends, with its axis parallel to that of the solenoid.. Find the magnetic flux through the loop. (*b*) A small circular loop of N turns and radius $R_3 < R_1$ is completely inside the solenoid, far from its ends, with its axis parallel to that of the solenoid. Find the magnetic flux through this small loop.

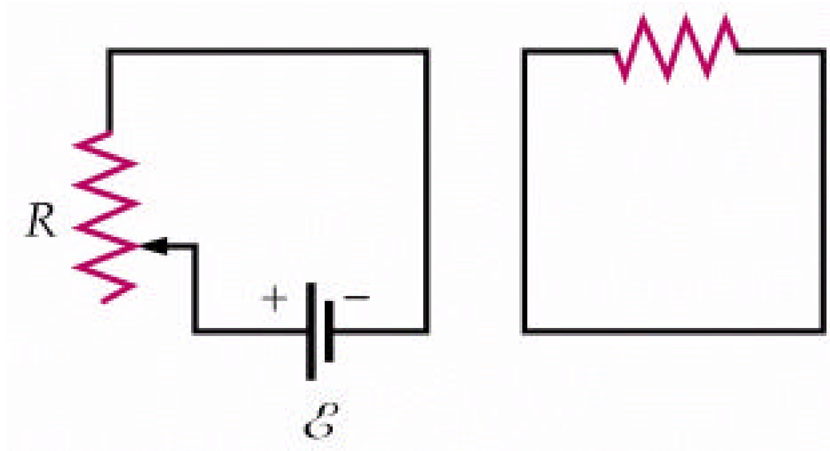
10 ·· A long, straight wire carries a current I. A rectangular loop with two sides parallel to the straight wire has sides a and b with its near side a distance d from the straight wire, as shown in Figure 30-29. (*a*) Compute the magnetic flux through the rectangular loop. (*Hint:* Calculate the flux through a strip of area $dA = b\,dx$ and integrate from $x = d$ to $x = d + a$.) (*b*) Evaluate your answer for a = 5 cm, b = 10 cm, d = 2 cm, and I = 20 A.



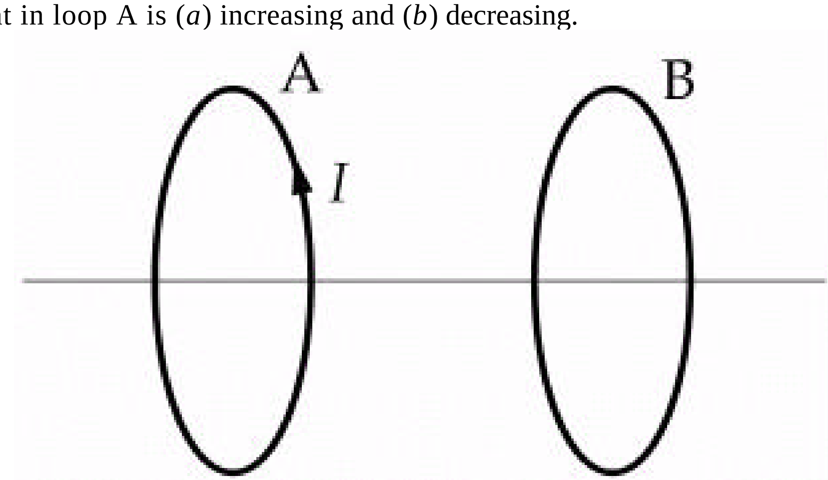
14 · A uniform magnetic field **B** is established perpendicular to the plane of a loop of radius 5.0 cm, resistance 0.4 Ω. The magnitude of **B** is increasing at a rate of 40 mT/s. Find (*a*) the induced emf in the loop, (*b*) the induced current in the loop, and (*c*) the rate of Joule heating in the loop.

20 ·· At the equator, a 1000-turn coil with a cross-sectional area of 300 cm^2 and a resistance of 15.0 Ω is aligned with its plane perpendicular to the earth's magnetic field of 0.7 G. If the coil is flipped over, how much charge flows through it?

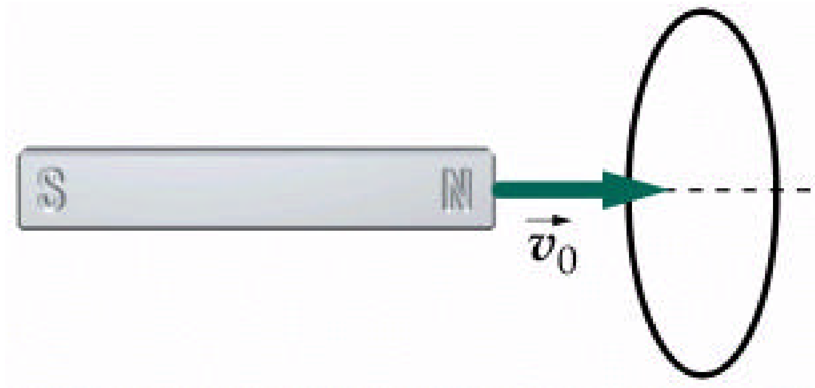
25* · Give the direction of the induced current in the circuit on the right in Figure 30-32 when the resistance in the circuit on the left is suddenly (*a*) increased and (*b*) decreased. Note that when *R* is constant, ***B*** in the loop to the right points out of the paper.



26 ·· The two circular loops in Figure 30-33 have their planes parallel to each other. As viewed from the left, there is a counterclockwise current in loop A. Give the direction of the current in loop B and state whether the loops attract or repel each other if the current in loop A is (*a*) increasing and (*b*) decreasing.

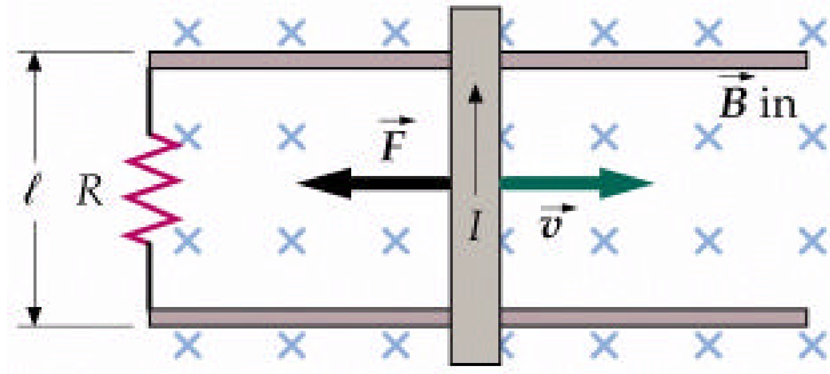


27 ·· A bar magnet moves with constant velocity along the axis of a loop as shown in Figure 30-34. (*a*) Make a qualitative graph of the flux ϕ_m through the loop as a function of time. Indicate the time t_1 when the magnet is halfway through the loop. (*b*) Sketch a graph of the current I in the loop versus time, choosing I to be positive when it is counterclockwise as viewed from the left.

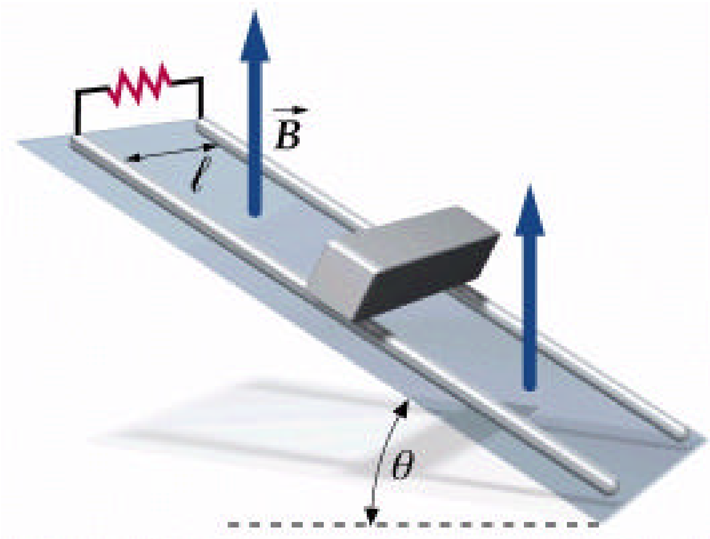


30 · A rod 30 cm long moves in a plane perpendicular to a magnetic field of 500 G. The velocity of the rod is perpendicular to its length and the potential difference between the ends of the rod is 6 V. Find (*a*) the electrostatic field ***E*** in the rod, (*b*) the magnetic force on an electron in the rod, and (*c*) the speed of the rod.

31 · In Figure 30-14, let B be 0.8 T, v = 10.0 m/s, ℓ = 20 cm, and R = 2 Ω. Find (a) the induced emf in the circuit, (b) the current in the circuit, and (c) the force needed to move the rod with constant velocity assuming negligible friction. Find (d) the power input by the force found in part (c), and (e) the rate of Joule heat production I^2R.



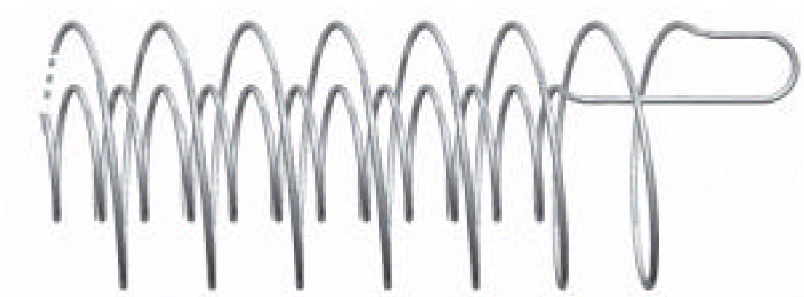
39 ·· In Figure 30-38, a conducting rod of mass m and negligible resistance is free to slide without friction along two parallel rails of negligible resistance separated by a distance ℓ and connected by a resistance R. The rails are attached to a long inclined plane that makes an angle θ with the horizontal. There is a magnetic field B directed upward. (*a*) Show that there is a retarding force directed up the incline given by $F = (B^2\ell^2 v\cos^2\theta)/R$, (*b*) Show that the terminal speed of the rod is $v_t = (mgR\sin\theta)/(B^2\ell^2\cos^2\theta)$.



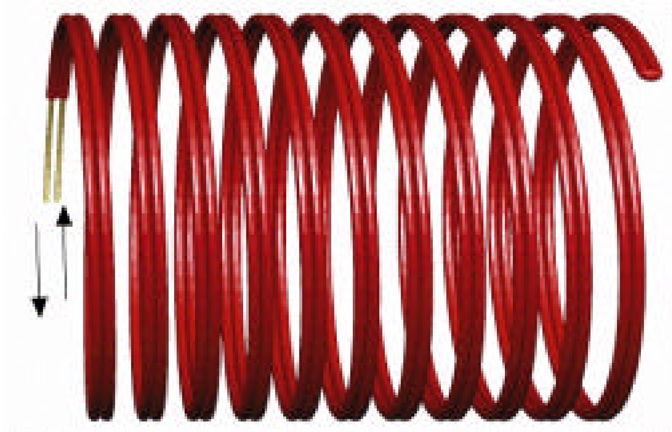
49* · A coil with a self-inductance of 8.0 H carries a current of 3 A that is changing at a rate of 200 A/s. Find (*a*) the magnetic flux through the coil and (*b*) the induced emf in the coil.

52 ·· Two solenoids of radii 2 cm and 5 cm, respectively, are coaxial. They are each 25 cm long and have 300 and 1000 turns, respectively. Find their mutual inductance.

54 ·· Figure 30-43 shows two long solenoids each with 2000 turns of wire. The outer solenoid is 20 cm long and has a diameter of 2 cm. The inner solenoid is 10 cm long and has a diameter of 1 cm. Find the effective inductance of this arrangement.



53* ·· A long, insulated wire with a resistance of 18 Ω/m is to be used to construct a resistor. First, the wire is bent in half, and then the doubled wire is wound in a cylindrical form as shown in Figure 30-42. The diameter of the cylindrical form is 2 cm, its length is 25 cm, and the total length of wire is 9 m. Find the resistance and inductance of this wire-wound resistor.

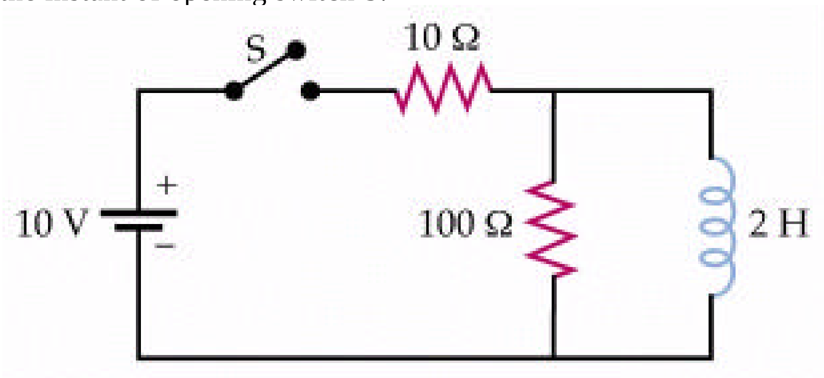


57* · If the current through an inductor were doubled, the energy stored in the inductor would be (*a*) the same. (*b*) doubled. (*c*) quadrupled. (*d*) halved. (*e*) quartered.

61* ·· A solenoid of 2000 turns, area 4 cm^2, and length 30 cm carries a current of 4.0 A. (*a*) Calculate the magnetic energy stored in the solenoid from $\frac{1}{2}LI^2$. (*b*) Divide your answer in part (*a*) by the volume of the solenoid to find the magnetic energy per unit volume in the solenoid. (*c*) Find B in the solenoid. (*d*) Compute the magnetic energy density from $u_m = B^2/2\mu_0$, and compare your answer with your result for part (*b*).

65* · The current in a coil with a self-inductance of 1 mH is 2.0 A at $t = 0$, when the coil is shorted through a resistor. The total resistance of the coil plus the resistor is 10.0 Ω. Find the current after (*a*) 0.5 ms and (*b*) 10 ms.

72 ·· Given the circuit shown in Figure 30-46, assume that switch S has been closed for a long time so that steady currents exist in the circuit and that the inductor L is made of superconducting wire so that its resistance may be considered to be zero. (*a*) Find the battery current, the current in the 100-Ω resistor, and the current through the inductor. (*b*) Find the initial voltage across the inductor when switch S is opened. (*c*) Give the current in the inductor as a function of time measured from the instant of opening switch S.



80 · True or false:

(a) The induced emf in a circuit is proportional to the magnetic flux through the circuit.

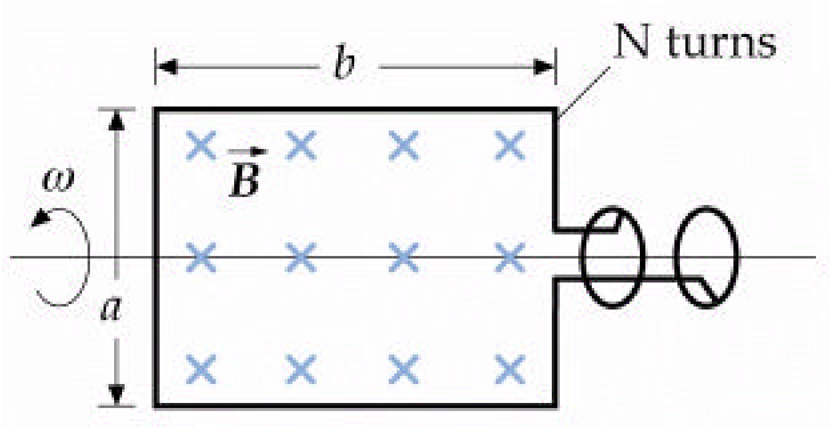
(b) There can be an induced emf at an instant when the flux through the circuit is zero.

(c) Lenz's law is related to the conservation of energy.

(d) The inductance of a solenoid is proportional to the rate of change of the current in it.

(e) The magnetic energy density at some point in space is proportional to the square of the magnetic field at that point.

86 ·· Prior to about 1960, magnetic field strength was measured by means of a rotating coil gaussmeter. This device used a small loop of many turns rotating on an axis perpendicular to the magnetic field at fairly high speed and connected to an ac voltmeter by means of slip rings like those shown in Figure 30-48. The sensing coil for a rotating coil gaussmeter has 400 turns and an area of 1.4 cm^2. The coil rotates at 180 rpm. If the magnetic field strength is 0.45 T, find the maximum induced emf in the coil and the orientation of the coil relative to the field for which this maximum induced emf occurs.



93* ·· A long solenoid has n turns per unit length and carries a current given by $I = I_0 \sin \omega t$. The solenoid has a circular cross section of radius R. Find the induced electric field at a radius r from the axis of the solenoid for (a) $r < R$ and (b) $r > R$